FROM VULNERABILITY ASSESSMENT TO ADAPTATION PROGRAMMEDESIGN : A CASE STUDY FROM THE CENTRAL GANGA BASIN, INDIA

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1. INTRODUCTION

Natural resources such as water and land are the primary source of livelihoods for a majority of the people in developing countries. Different pressures including rising population,rapid urbanization and the need for increasing agricultural productivity are putting extreme stress on the existing natural resources and raising uncertainty to their availability for future generations. To add to these existing pressures, climate change is furthermore stressing these resources. Changes in temperature and rainfall pattern probably due to climate change, are becoming important drivers of impacts on natural resources. Water resources, primarily are facing numerous pressures which not only impact the water quality but also the overall water availability. Ganga basin, which is one of the most fertile regions of India, is facing numerous problems related to water availability. Rise in both surface water usage as well as groundwater extraction to meet agricultural needs is straining the water resources in the basin. There are also losses during distribution and pumping inefficiencies. Direct impacts due to change in climate parameters are being manifested in certain parts of the basin. Apart from the direct impacts, the changes in glacier flow melt will also have implications for water availability in the region. In the short term, the flow might increase due to rise in melting of glaciers while in the long run there will be a likely decrease in river flow. These set of pressures will have a compounded impact on the natural resources and livelihoods of the millions of people in the basin who are largely dependent on agriculture and other natural resources.

Vulnerability assessments are useful tools to understand the current pressures and challenges in the water sector. Apart from that they also help in identifying appropriate adaptation measures and strategies to meet the challenges of climate change along with other stressors. Adaptation has become an increasingly important response mechanism to make the communities more resilient towards climate change and enhance their adaptive capacity. However, adaptation in water sector will have to address many challenges including non-climatic stressors and emerging uncertainties.

2. OBJECTIVES

The Living Ganga Programme (LGP) is a five year initiative being implemented by WWF –India and funded by HSBC Bank. The programme essentially focuses on climate change across the upper Ganga basin, focusing on river restoration, community education and engagement, business and governance involvement and biodiversity conservation. It aims to bring together knowledge and experience in Environmental Flows, climate adaptation and water allocation coupled with wastewater management and wise energy management in the water sector in Ganga Basin.

Climate Adaptation is one of the major components of the LGP. It largely had the objective of carrying vulnerability assessment at a macro level for the Ganga basin followed by a more detailed vulnerability assessment at the community level and finally implementing adaptation pilots for the most vulnerable regions and sectors based on the results of the two studies. As apparent the methodology had a top-down approach moving from the basin level to the community level. The focus of the climate adaptation component is on water and agriculture in the region, primarily in the state of Uttar Pradesh and Uttarakhand.

3. MACRO LEVEL VULNERABILITY ASSESSMENT

The first step of the component was to conduct a macro level vulnerability assessment for the Ganga Basin. The assessment was done as a comparison between all the districts (administrative unit) of the states of Uttar Pradesh

and Uttarakhand. The main objective of this vulnerability assessment was to understand the vulnerabilities of people and livelihoods which are primarily dependent on climate sensitive natural resources. In accordance to the objectives, the target groups chosen for this assessment were people and the key natural resources which are crucial for livelihoods within an ecosystem. Current vulnerabilities to climate change were assessed for the target groups using an index based approach. Such approach which essentially uses indicators is a commonly used analytical tool for vulnerability assessments as it helps in quantifying natural processes and conditions. In this approach a combination of indicators suitable to the study area or group are chosen which are indicative of the key factors determining vulnerability.

The methodology for assessing the vulnerability for this study was selected after reviewing series of methodologies applied in indicator based vulnerability assessments in the literature. The method which was found to be most appropriate and replicable for this study was the LVI – IPCC (Livelihoods Vulnerability Index) methodology[1]. The basic methodology of this case study was adopted for this assessment after modifications so that it is relevant to the study for the Ganga Basin. Except for the main structure, all the indicators were chosen on the basis of relevance to the study area and data availability. The methodology places multiple indicators under the broad umbrella of three factors which define vulnerability – exposure, sensitivity and adaptive capacity. Under each of these components, distinct profiles were created having indicators within them. Table 1 summarizes the profiles and indicators chosen under each component. Indicators related to climate parameters, natural resources and livelihoods along with infrastructure were taken into consideration thus ensuring that physical, natural as well as socio-economic systems are covered. These indicators act as a proxy medium to reflect the state of exposure, sensitivity and adaptive capacity of the area. Vulnerability is measured by aggregating these indicators through appropriate statistical methods.

Table 1: Indicators for Vulnerability Assessment

Component	**Profile**	**Indicators**
Exposure	Climate	• Average Temperature • Rainfall
	Demographics	• Sex Ratio • Population in the age group 0-6 • Decadal Population Growth • BPL Population
Sensitivity	Ecosystem	• Change in forest cover • Land use pattern (Kharif& Rabi) • Groundwater
	Agriculture	• Crop Production • Land Capability • Irrigation pattern • Agricultural Dependency ratio
Adaptive Capacity	Socio – Economic structure	• Livestock population • Literacy rate • Access to basic amenities (Drinking water, electricity, *pucca* houses) • Biomass Dependency • Infrastructure (Educational, Health, Banking and Communication facilities, Road density)

The calculation of the index involves four steps moving from indicators to profiles and eventually to the final vulnerability index. After the initial step of selection of indicators, secondary data was collected for the selected indicators from government departments. The data for the indicators was then normalized using the Human Development Index (HDI) formula to bring consistency. The next step involved the calculation of each profile value (***Climate, Demographics, Agriculture, Ecosystem and Socio- economic Profiles***by combining the data for the indicators under it. The profile values in turn were the inputs for calculating the values for the three components: **Exposure, Sensitivity and Adaptive Capacity**. The **Vulnerability index** for the region was

derived by combining the values of these components. GIS techniques were used for the generation of thematic maps as well as graphically presenting data.

RESULTS:

Exposure: The final values for the exposure levels of the districts shows that almost 50% of the total 83 districts lie in the medium exposure category. In case of Uttarakhand these include districts such as TehriGarhwal and Pithoragarh whereas in Uttar Pradesh this category of districts covers almost the entire state except the eastern region. About 20 % of the districts in the study area are found to be highly exposed to the changes in the climate and many of these are the predominant urban districts of these states. The other districts under this category namely Uttarkashi, Bijnor, Bareilly, Faizabad and JyotibaPhule Nagar are the ones which have experienced higher levels of change in temperature and precipitation. The districts which are found to be lesser exposed to climate change are primarily found to be located in the eastern parts of UP as well as Uttarakhand. Higher sex ratio along with relatively lower level of urbanization and population growth are the pushing factors for the districts in Eastern UP being classified under this category. However, being placed in this category doesn't imply that these districts are not vulnerable to climate change; it just indicates their relative exposure levels when compared with other districts.

Sensitivity: The values for the sensitivity component show that almost the entire state of UP is in the medium to high division. The western UP in particular has maximum number of districts in the highly sensitive category. Higher groundwater extraction and excessive dependence on irrigation are governing factors for the higher sensitivity values in these districts. Due to this rising pressure on surface and groundwater resources as indicated through the data, the ecosystem and agriculture system in this basin are likely to be more sensitive to the shifts in temperature and precipitation pattern. For the state of Uttarakhand, the division is mainly into low and medium category primarily because the highly influential variable of groundwater in case of UP was not taken for this state. The only district which is an outlier is Udham Singh Nagar mainly due to a combination of maximum reduction in forest cover and larger area being dependent on irrigation.

Adaptive Capacity: From the final adaptive capacity values it is evident that most of the districts have very low adaptive capacity as the level of infrastructure development and access to basic amenities is substantially low. Higher adaptive capacity values are seen only in the foremost urban districts such as Dehradun, Meerut, GautamBudh Nagar, Ghaziabad and Lucknow. Majority of the districts are very low in regard to provision of basic necessities of living especially in Eastern UP and Bundelkhand region as well as hilly districts of Uttarakhand. Even in terms of infrastructure development such as education and health facilities these districts rank very low as compared to the few urban districts of the state showing discrepancy in development levels. These districts are also highly dependent on biomass (firewood, crop residue and cowdung cake) as a large proportion of the households (60 - 90 %) use it as fuel for cooking purposes. The figure reflects the high dependence on natural resources for energy requirements.These variables on infrastructure and access to basic amenities show a general trend that better services and resources are limited to urban districts. On the other hand, the other districts lack in terms of infrastructure development and in case of any changes in the climate these areas might not be able to cope up with the severity. These areas need more attention for the general upliftment of these lesser developed areas of UP along with making them better adapted to climate change.

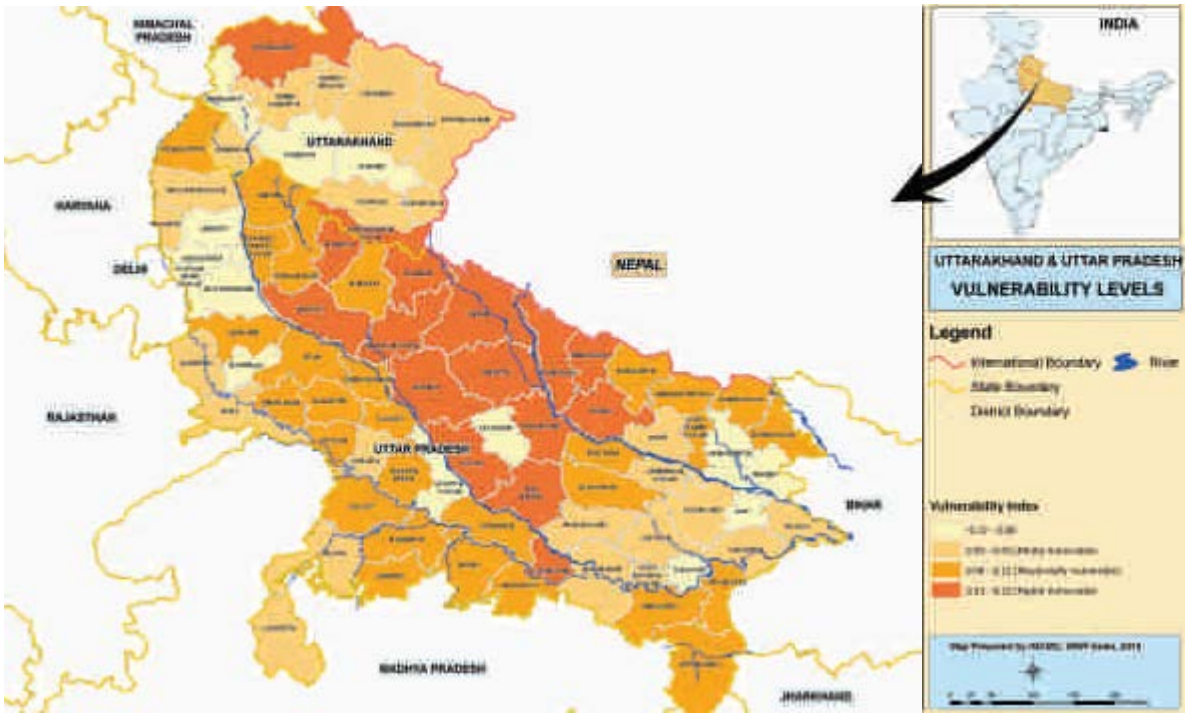

Figure 1: Map showing the Vulnerability levels of the districts of Uttar Pradesh and Uttarakhand

Vulnerability :The final vulnerability index for the districts was calculated by combining all the three components of exposure, sensitivity and adaptive capacity. The cumulative values for the index lie between -1 and +1 with lesser value symbolizing lower vulnerability of the district and were divided into four classes for the purpose of analysis (Map). The least vulnerable districts include the key urbanized districts of these two states. Owing to higher adaptive capacity these districts fall under this category. Most of the districts along the river Ganga are highly or moderately vulnerable. This is because their exposure and sensitivity levels are very high whereas the adaptive capacity levels are very low. There has been comparatively more climatic variability in these regions due to uncertain precipitation pattern and increasing temperature over the last decade. The sex ratio is low and a large population is below poverty line. These together have resulted in high exposure values. The pressure on the ecosystem is more in these districts with more land utilization, higher groundwater extraction and larger area under irrigation, which has made them more sensitive to any form of impacts in context of climate variability. Lower levels of development in the form of infrastructure and low levels of access to resources as well as assets have resulted in lower coping capacity of the people in these districts which makes them more vulnerable to any form of impacts occurring due to climate change.

4. DESIGNING AN ADAPTATION STRATEGY

The above assessment reflects both the natural and social vulnerabilities for a community arising out of climate and non-climate induced stressors, and it is important to note that these are interlinked especially in an economy where the viability and security of peoples' livelihoods are dependent on the local natural resource base. Indian economy, especially the rural economy is closely tied to its natural resource base and to the climate sensitive sectors such as agriculture, forestry and water resources. Therefore, the economy and hence peoples' livelihoods are majorly threatened by current climate variability and projected changes in climate. Those with least resources – natural, financial and capacity/knowledge - have the least capacity to adapt & are thus the most vulnerable[2].

Adaptation is an opportunity to promote holistic and integrated development which can cut across sectors and nested institutions to establish multi-level interactions & linkages. "Adaptation is action that involves adjustments in natural or human systems and behaviours to reduce vulnerability to actual and expected changes in climate." While there is a lot of uncertainty and skepticism on the projected forecasts of climate change,

actions need to be started with addressing the current vulnerability of those with limited capacity and resources, to building their resilience to disasters and moving out of poverty. This is where adaptation responses become imperative. An ecosystem based adaptation strategy can help communities secure their livelihoods, maintain their local safety nets, and improve their capacity to adapt.

*Ecosystem-based adaptation can be defined as "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change." (*CBD's AHTEG)[3]As explained above, ecosystem based adaptation will not only help to conserve the biodiversity and maintain healthy ecosystems, but it can generate various social and economic benefits for the communities dependent on these ecosystems, as well as build on the traditional knowledge and practices of indigenous peoples and local communities, including women thereby building their capacities. WWF's adaptation strategy for the Ganga basin has built on this concept of ecosystem based adaptationand incorporated activities which would not lead to regrets in future both from the point of view of coping with environmental degradation and climate change.

A. Selection of Area of Intervention

In order to identify the vulnerable districts which are also highly sensitive, the sensitivity map (including agriculture and ecosystem profiles) was overlaid on the final vulnerability Index map. This resulted in a map which shows that most districts along the river Ganga and in its floodplains are highly or moderately vulnerable. Moreover, since WWF India's Living Ganga Programme focused on the 800 km stretch of the Upper Ganga Basin, from Kanpur to Gangotri, the Climate Change Adaptation interventions were assessed for the districts of Hardoi, Kannauj, Etah, Mainpuri and Badaun.

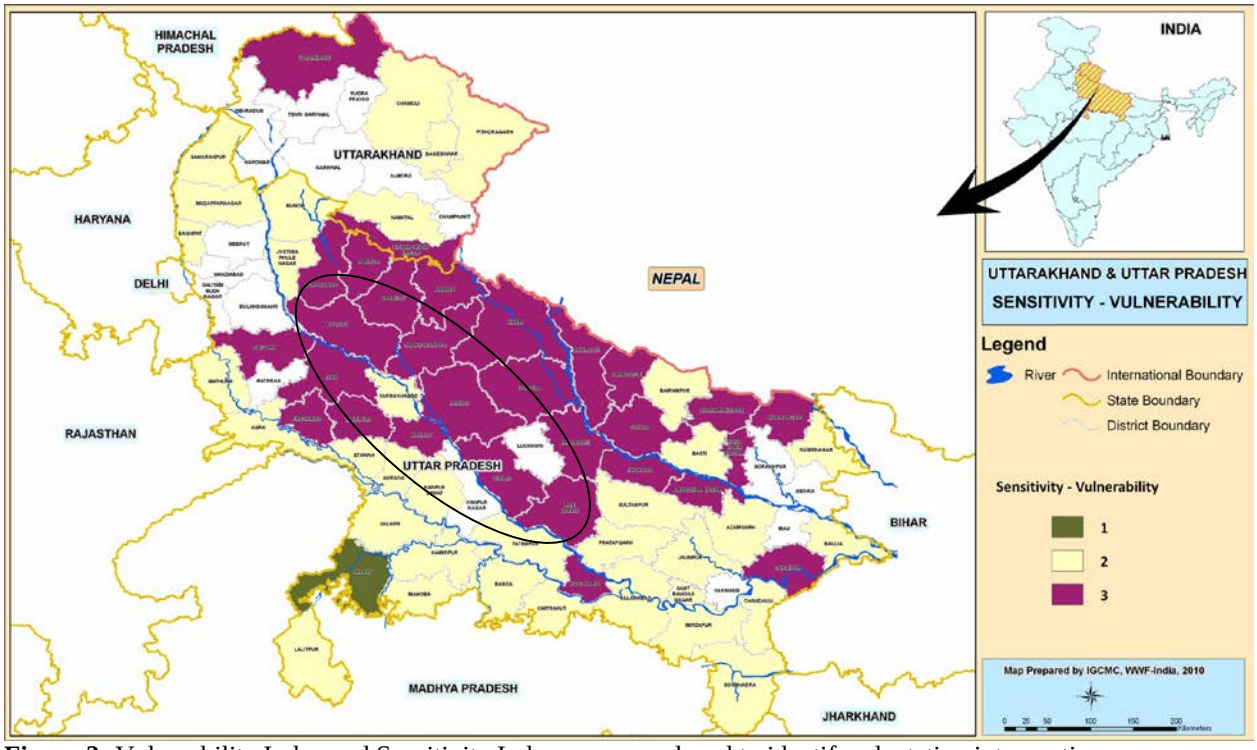

Figure 2: Vulnerability Index and Sensitivity Index maps overlayed to identify adaptation intervention areas.

Scoping exercises conducted on the ground in these focus districts highlighted the growing stress on land and water as one of the key vulnerabilities facing the economy and the local communities. Over usage of ground water and surface water for irrigation are the main causes of high sensitivity levels, which in turn reflect on the inefficient irrigation practices and the water-energy nexus. The increasing variability in rainfall has further impacted the water availability scenario in these areas. The reliance on chemical fertilizers and pesticides to

increase productivity levels has significantly affected the soil quality in these regions. In the absence of alternative livelihood options locally, an agriculture-based livelihood structure is the principal source of income for the local communities. Its survival, therefore, has overriding implications for them in terms of their decision-making criteria for protecting and conserving the ecosystem services of the natural resource base. Such decisions are also critical for the natural wetland-agro-ecosystem, which is unique in this part of U.P., and which are the key habitat for numerous species.

The scoping exercise also highlighted a very important outcome. Kanpur district was identified as one of the least vulnerable district in the macro vulnerability assessment study. However, field visits and discussions with stakeholders showed various blocks within the district has highly vulnerable with high poverty levels because of the sodic nature of soil, discontinued surface irrigation options resulting in groundwater levels reaching critical zones and absence of alternate livelihood options like presence of industries and services sector.

The scoping exercise and stakeholder consultations resulted in selection of Kanpur and Hardoi districts as the areas of intervention for the Living Ganga Programme's Adaptation component. In addition, the programme was implemented in partnership with local grassroot non-governmental non-profit organizations with the objective of capitalizing on their strengths of familiarity with the local socio-cultural-economic conditions; having a presence in the field; and long term sustainability of the efforts to build resilience of both human and ecosystem capacities.

Specifically, interventions were designed for:

- Kuwarpur, Harnoo, Nadiha Buzurd and Rwalalpur villages, Shivrajpur Block, Kanpur District (implemented by Shramik Bharti, Kanpur);
- Darapur and Nevada villages, Mallawan Block, Hardoi District (implemented by Humana People to People India, New Delhi); and
- Kazipur and Fazalpur villages, Madhoganj Block, Hardoi District (implemented by Sarvodaya Ashram, Hardoi).

b. Micro level vulnerability Assessment:

Micro level vulnerability assessment was carried out to have an understanding of major impacts of climate change at village level and the local vulnerabilities which could not be captured in Macro level analysis. Out of the five identified vulnerable districts, two districts were short listed based on scoping exercise for community level vulnerability assessment and adaptation interventions. Through community level VA, we could get an understanding of regional disparities which are critical in influencing the vulnerability of a region.

The sites chosen for community level VA were located in Kanpur Nagar and Hardoi districts of Uttar Pradesh as listed above. The community level vulnerability assessment was done using Participatory Rural Appraisal (PRA) tools (like historical timelines, resource maps, focus group discussions with groups of women, men, and older generation). Discussions centered aroundunderstanding changes observed in climate and the subsequent impacts on water, agriculture and biodiversity over the last 10-20 yrs, on existing infrastructure set –up and access to resources, and on coping mechanisms used by villagers to deal with the changes perceived.

RESULTS:

Exposure: In all the villages, people have observed and experienced changes in the climatic pattern. Seasonal shifts have occurred with more erratic patterns. Summers have become longer along with an increase in summer temperature. Monsoons have become more erratic along with a delay in onset of rainfall. While, the total rainfall has reduced, very heavy rainfall events in short span of time have become more frequent resulting in higher runoff and lesser recharge of groundwater. The duration and intensity of winter season has been reduced. These together indicate that these regions are considerably exposed to climate change.

Sensitivity: Discussion related to key natural resources in the region highlighted the high sensitivity of these areas. Water demand for irrigation has substantially increased to meet the needs of higher crop production. Over – extraction and lesser recharge have led to falling water levels in almost all the villages. The borewells require digging to further depths after every few years, many becoming defunct in the process. The number of pump sets have also been constantly increasing in this area.The time and frequency of irrigation required has risen over the last decade resulting in increased production costs. Especially in Shivrajpur Block, one of the main concerns expressed by the farmers was the declining water availability and they expect measures which can augment water resources.

Reduction in water availability is also apparent from the state of water bodies such as ponds and wetlands. The wetlands and ponds remain dry for most parts of the year. The dimensions of many wetlands with respect to length, width and depth have seen a reduction there by reducing their water-holding capacities. In some cases, the area meant for ponds and wetlands has been encroached upon for agricultural purposes. As these wetlands are crucial for recharging the acquifer, these changes can probably have impacts on groundwater level also.

The area under agriculture has increased substantially. To increase the crop production, farmers have started using hybrid seed varieties instead of traditional crop varieties which has also increased input use of fertilizers, pesticides and irrigation. Still, the quality and quantity of some crops has decreased. Deterioration in quality and size of fruits has also been observed. Due to lesser availability of water, the farmers have been forced to switch over to low water requiring crops. Moreover, high use of chemicals has led to deterioration of soil quality. Earthworms, which are very beneficial for the soil and crops, have been reduced drastically in number. The farmers have noted a significant increase in pest infestation such as termites and insects which damage crops. Termite infestation has caused major damages to the crops and trees.

Villagers have also noted many changes in biodiversity of the region. Many trees such as Mango (*Mangiferaindica*), Neem*(Azadirachtaindica*) and Jamun (*Syzygiumcumini*) have been reduced in numbers. Phenological changes have been observed by the villagers. In most villages, people have noted reduction in population of many bird species. Vultures, primarily have disappeared.

Adaptive Capacity: The socio-economic conditions and infrastructure development of a region are factors of adaptive capacity of communities. None of the villages in the study area had provisions for health facilities. While some villages had health sub-centers constructed, they remainedunfunctional. There are Anganwadi and ASHA representatives in the village for providing medical help and promoting health care. Agriculture is the main source of livelihood. However, with rising input costs and decreasing production, food security needs of households are barely fulfilled leaving very little surplus for sale and income. In all the villages, wage labour was used to supplement their income. Alternate livelihood options include dairy farming and migration. The number of people migrating from the villages have been increasing year-by-year, with many going to cities such as Kanpur, Delhi for jobs or as laborers.

VULNERABILITY:

With observed changes in climatic parameters and noticeable impacts observed on key natural resources of water and soil, the villages are highly sensitive to climate change. Their high dependence on agriculture along with low adaptive capacity due to lack of sufficient development makes the communities in these regions highly vulnerable. There is a need to implement appropriate adaptation strategies which can help in augmenting the natural resources while providing better livelihoods for the communities.

5. THE APPROACH AND SOME INITIAL RESULTS

The Adaptation strategy implemented is based on following an integrated approach with multiple strands with the overall goal of building resilience against climate variability and risks, by enhancing the response capacities of the natural resource base as well as the adaptive capacities of the communities. Also as explained in the earlier section, given the uncertainties of climate risk projections at the local level, the adaptation strategy was based on the understanding that the interventions will not only help communities cope with current climate variability but will also help them to adapt to future climate change if and when they occur. Therefore, the programmewas designed to increase the productivity of the natural resource base, strengthen local institutions and build social capital, and transfer knowledge and technology.

Based on the broad theme of Water Conservation, four adaptation pilots are being implemented in the Kanpur and Hardoi districts of U.P[4].These are a mix of technology interventions and capacity enhancement to achieve the overall goal.

With an over-arching aim of promoting ecosystem based adaptation, the physical and management interventions aimed to conserve water through water storage and irrigation efficiency practices; promotion of better agronomic practices, and wetland restoration. Strengthening existing community institutions (like the womens' self help groups) and forming new community based institutions (like farmers' clubs and water user committee) along with trainings, exposure visits and skill development helped build the social capital of the communities. A mix of strengthening the traditional coping strategies (like use of indigenous varieties of seeds, renovation and better management of irrigation channels) and introducing new innovative strategies (like introduction of amrit-

pani as a bio-pesticide, System of Rice Intensification, and automated weather station to help local agricultural decision making to be tuned with local weather data) also helped to build on the physical interventions while developing social capabilities. While the physical interventions were aimed at enhancing the adaptive capacities of the communities through adjustments in resources and technologies, strengthening of social capital is adaptation through adjustment in behavior. Transfer of knowledge to communities results in adjustments in technologies as well as in behavior[5].

Pilot 1: Enhancing productivity through Soil and Land Management

Problem: Many stretches of the Ganga Basin are facing problems of sodic or alkaline soil which along with poor irrigation management has deteriorated the quality of soil making the land uncultivable or in the case of cultivable land negatively impacting crop productivity. Further the sodic soils and the hard pan that is often formed beneath the ground reduces recharging of the aquifer and so the groundwater resources of this area are further stressed. Along with organic methods of soil quality improvement, it is imperative to identify and implement measures of water conservation and groundwater recharge to enhance water availability.

Area of Intervention: 4 villages in Shivrajpur Block, Kanpur Nagar district (NGO partner – ShramikBharti); 2 villages in Madhoganj block, Hardoi district (NGO partner – Sarvodaya Ashram) and 2 villages in Mallawan block, Hardoi District (NGO partner – Humana People to People India)

Activities

- With respect to sustainable agricultural practices, the emphasis is on promoting integrated pest and disease management practices through the use of low water requiring rice and wheat crop varieties, organic compost and fertilizers (like amritpani, amritkhad and pit compost of agriculture waste, green mulching with dhaincha), micro-nutrient management following soil quality tests, and controlling irrigation practices (both the quantity of water and the number of irrigation required).
- In order to deal with climate variability, crop diversification and short duration crop varieties are being promoted. In addition, local varieties of rice and wheat are being identified with selected farmers being encouraged to make seeds.
- An Automated Weather Station installed in village Darapur provides local weather data which is being used by local villagers through the assistance of the Krishi Vigyan Kendra, Hardoi.
- In order to improve the water retention capacity of the soil, it is also proposed to plant appropriate local plant species by developing plant nursery entrepreneurs.
- Social and human capital is being built through strengthening local institutions like womens' self help groups, and farmers clubs and tying them up with local Krishi Vigyan Kendras, NABARD and other local government agencies. Trainings and exposure visits for farmers are also being done to facilitate the application of sustainable agriculture methods in the present system.
- Artificial recharge of groundwater is being promoted by enhancing the recharge capacities of existing irrigation structures like conversion of defunct borewells into recharge borewells, as well as by developing new rainwater storage and recharge capacity through construction of handpump soak cum recharge pits, restoration of ponds to enhance their storage and groundwater recharge capacities, and check dam walls.

Some results:

- Sustainable agriculture - Farmers have benefited primarily in terms of reduction in input cost, due to less seeds being used and gradual replacement of commercial chemical fertiliser with indigenous organic fertlisers. Improvement in soil quality through application of required micro-nutrients (following soil quality tests), PSB culture and/or azotobacter, etc. have also helped improve productivity of crops. A total of 250 farmers benefited in the first year of promotion of better agronomic practices.

  For Wheat crop, demonstration results have shown a reduction in seed rate by 40 to 50%; reduction in cost of pesticides & fertlisers by 30 to 50%. Net profit for wheat has shown a wide range in increase - from 34 to 90%. Such an intervention will help to build economic resilience in terms of their ability to save more in normal years, and develop a buffer for years of stress.

  In the case of Black Gram, demonstration plots indicated increase in productivity by 45%. However, net profits have shown increases as high as 428%, primarily realized because of a sharp decline in input cost (seed rate reduced by 43% combined with replacement of chemical fertilizers with low-cost locally made organic fertilizers).

Similarly, Groundnut demonstration plot in Madhoganj block resulted in productivity increase of 140% and an increase in net profit margins of 270% (resulting from 40% reduction in seed usage rate and use of low-cost locally made bio-fertilisers and required micro-nutrients).

- The Check Dam constructed in Harnoo village (Kanpur district) has resulted in 25,615 cu.m. of additional water being collected and being available to 50 farmers in the village to cultivate rice in Kharif 2011. In addition farmers from 3 villages (Harnu, Bargadia, Padraha) in the downstream of the Nala on which the dam has been constructed benefited by the check dam. Recharge potential of this intervention can only be gauged after one monsoon cycle is experienced.

Pilot 2: Efficient irrigation practices in districts with canal irrigated areas:

Problem: According to a recent study conducted on behalf of WWF India, the overall water-use efficiency rate of the Kanpur Branch Canal (of the Upper Ganga Canal) is only approximately 30 % and for other irrigation systems in Uttar Pradesh including canals the efficiency lies between 30-40% (Sinha, 2010). This indicates the scope of improvement and efficiency which can be brought in the existing system by adopting simple measures.

Area of Intervention: Hardoin Branch of Sharda Canal, Mallawan block, Hardoi District (NGO – Humana People to People India)

Activities:

- Upgrading water distribution channels to improve water availability in the fields
- Mobilizing farmers to form water user and management groups to secure optimal irrigation practices.

Some Results:

- The reconstruction of a 1.5 km canal channel within the jurisdiction of Nevada village has resulted in removal of canal seepage water from the channel into neighbouring fields. After the reconstruction, approximately 7714 cu.m. of water was drained as a result of which 14,700 sq.m. of land was reclaimed for rice crop production.
- 270 farmers in Darapur and Nevada villages of Mallawan block have benefitted from this activity.

Pilot 3: Water and Energy Co –management and addressing options of cropping pattern change

Problem: Canals are not the only source of irrigation in the Ganga Basin. Water withdrawals using tubewells also forms an important source of water in many parts of the canal irrigated areas especially during periods of water shortage. The figures of total water depth when compared to the total water requirement, from canal and tubewell irrigation systems, reveal that much more water is being used than required. This reflects substantial stress on both surface and groundwater resources for irrigation purposes and wastage of energy. Improving awareness amongst farmers as well as improvements in cultivation practices reduces water and energy demand for irrigation as well as reduces input cost of the farmer.

Area of Intervention: Madhoganj block, Hardoi district (NGO – Sarvodaya Ashram) and Mallawan block, Hardoi District (NGO – Humana People to People India)

Activities:

- Retrofitting of pumpsets and pumpset usage practices (like height and length of pipes used, quality of pipes used, etc.) to increase their efficiency.
- Promotion of sustainable irrigation practices (like irrigating the plot upto only 80% of plot size).
- SRI (System of Rice Intensification) and improved wheat cultivation which require less water for irrigation are also being promoted. Setting up demonstration fields for both the crops and training of farmers to apply these systems in their fields are being carried out.

Some Results:

- Pumpset retrofitting resulted in diesel savings ranging from 21% to 49% following an improvement in water discharge rates ranging from 15% to 44%.
  It was also found that it is more cost-effective to maintain and repair pumpsets on regular basis rather than making large sporadic repairs.
- An irrigation practice (of irrigating farming plots only upto 80% basin length instead of the normal 100%) resulted in a 20% increase in water use efficiency in the case of Wheat crop, i,e., 20% more kilograms of wheat production per cubic metre of water used (Water use efficiency = fn(water used, productivity of crop)).

Pilot 4: Management of soil and water for restoration of critical habitats for species conservation (like Wetlands Restoration)

Problem: Wetlands form an integral part of the ecosystem and are crucial for the maintenance of biodiversity and natural resources, being a key habitat for the Sarus crane. The wetlands suffer from shallow water and high water turbidity. Although seasonally flooded by rains and leakages from irrigation canals in monsoon, most of them remain dry for 4 to 5 months in a year and are then completely/partially used for cultivation of crops and aquatic livelihoods (like fisheries, water chestnut cultivation), leaving remnants of agriculture such as pesticide residue. In addition they are important habitat for a variety of species. Restoration of these lakes and water bodies is essential, both for recharging the water level of aquifers and and for the survival of flora and fauna of the area.

Area of Intervention: Harnoo village, Shivrajpur Block, Kanpur District (NGO - ShramikBharti).

Activities:

- Biodiversity monitoring for flora and faunal species across a temporal span to assess the impact in the long run;
- Restoration of two of the seven wetlands in the village planned through measures such as desiltation, strengthening of embankments, proper outlet and inlets, and grass & broad – leaved tree plantation as well as creation of islands as nesting grounds for migratory bird species;
- Discouraging and stopping chemical-based agricultural activities and other water based livelihood activities, in the catchment area of the wetlands, to improve quality of runoff;
- Participatory implementation and monitoring plan, to ensure effective implementation, through the formation of a Wetlands Protection Committee.

Some results:

- During Kharif 2011, 22 farmers located in the wetland catchment areas, cultivated their lands and more than 50% did not use any pesticides. Similarly in Rabi 2011-12, all 30 farmers located in the catchment of the wetlands, are cultivating their land and 100% of them are convinced not to use any chemical pesticide. Allof them are using bio-pesticides like neem oil, amritpaani and amritkhad.
- A 35 member Wetland Protection committee formed in the village with the support of the gram panchayat and gram sabha.
- A biodiversity inventory assessment in the post-monsoon season recorded around 87 macro phytic species belonging to forty three families in the seven wetlands currently in Harnoo village. Four species of anurans and six Pisces identified; Forty eight avian species belonging to 21 families are noticed.

6. LEARNINGS& CHALLENGES

Although preliminary results are coming in and they are encouraging, building resilience to climate variability and climate change is a long term process.

When farmers benefit financially, practices can spread fast. Promoting biological fertilisers and pesticides, and seed management practices has reduced input costs significantly for the farmers such that a larger number of farmers beyond the trial lot farmers are eager to learn and practice the best management practices promoted for sustainable agriculture, pumpset retrofitting, and irrigation practices. Economic resilience is the first step to building long term resilience both in terms of social capital and natural capital.

Villagers see business opportunities in some practices (e.g. amrith-pani bio pesticide; vermicompost; tree nursery) which is an additional incentive for some in the villages.

Information sharing on climate change impacts and the risks is very important for all nested institutions at different levels, e.g., villagers, government agencies, civil society groups and funding organisations. A common understanding of the risks involved can help to chart a single course of action.

However, strengthening and sustaining the village level institutions is a learning process in itself and this requires long-term involvement.

Since adaptation is a long term process needing long term involvement and commitment, technical and institutional support, along with financial commitment also needs to be long term. This is one of the biggest challenges.

In addition the village level institutions need to be integrated with other nested institutions at different levels to make the resilience building a sustainable process. This requires mainstreaming adaptation planning into local, national and international developmental processes.